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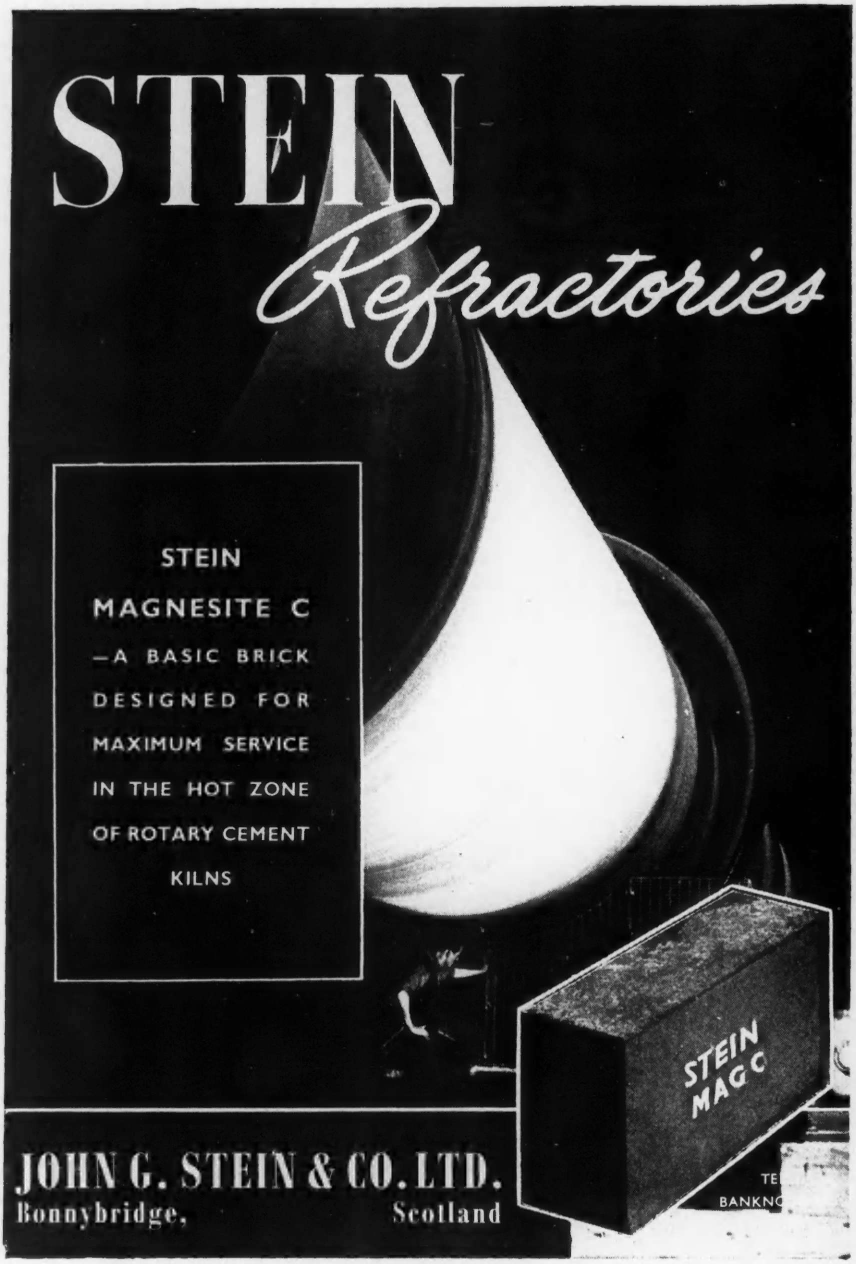

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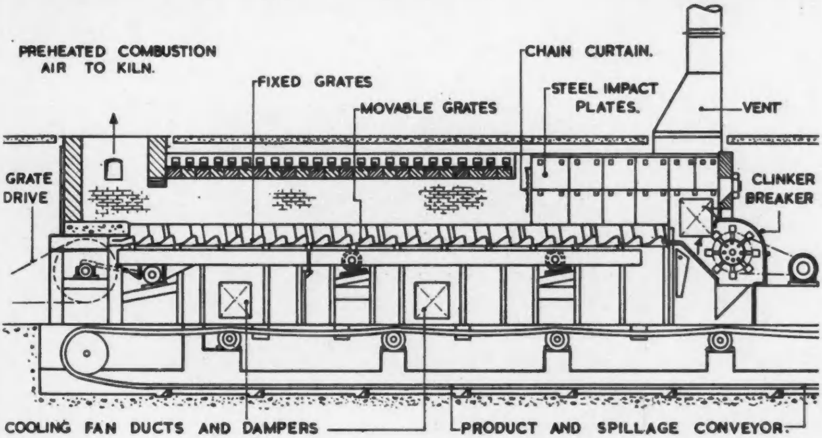

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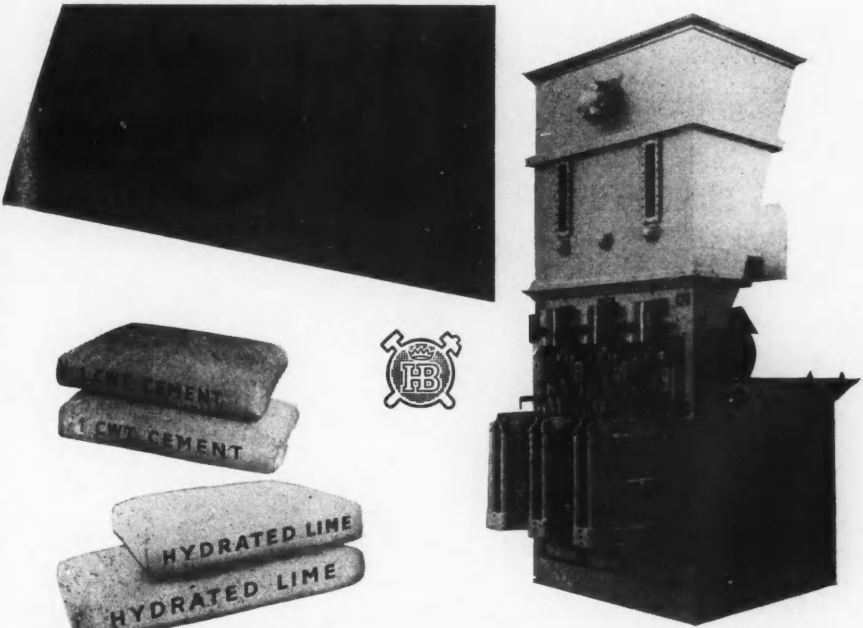

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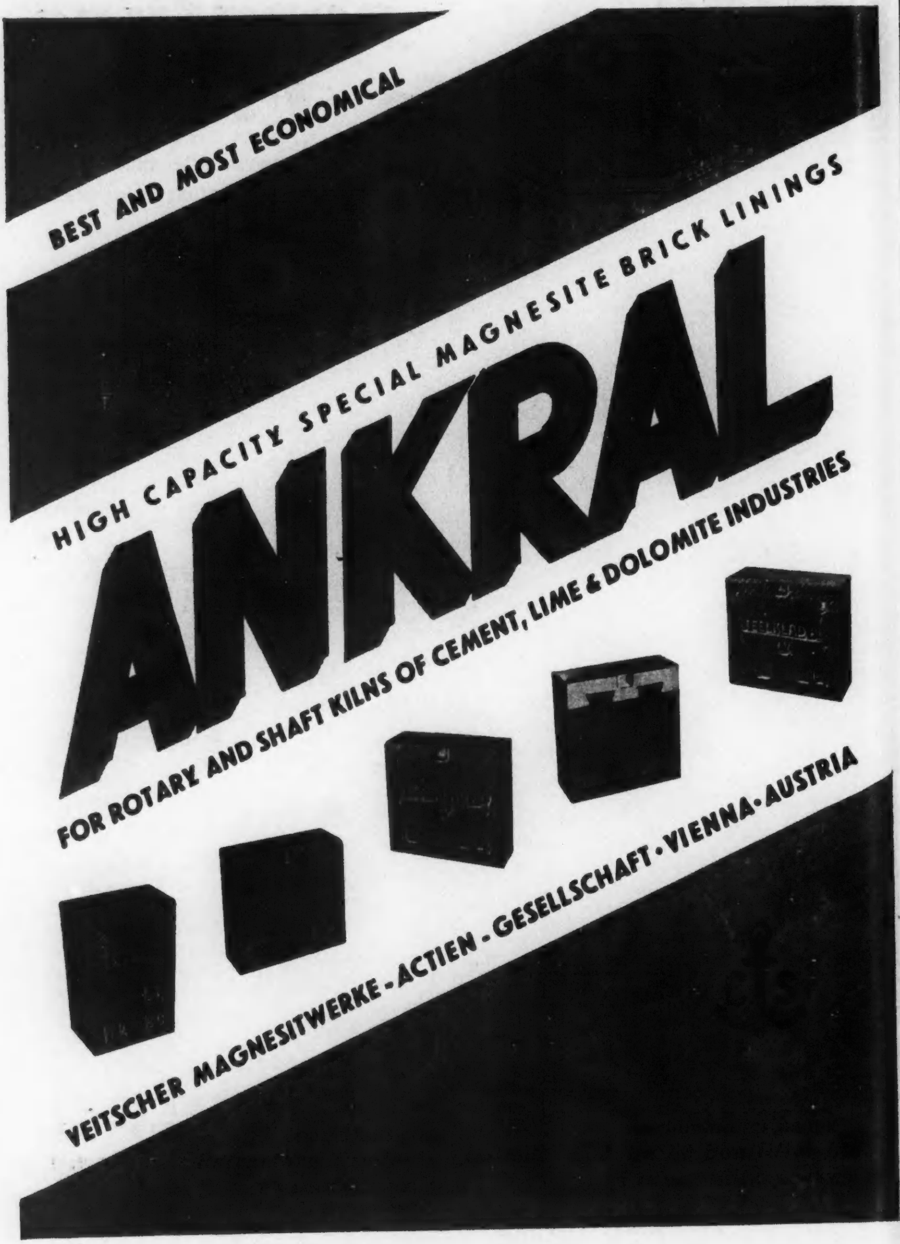
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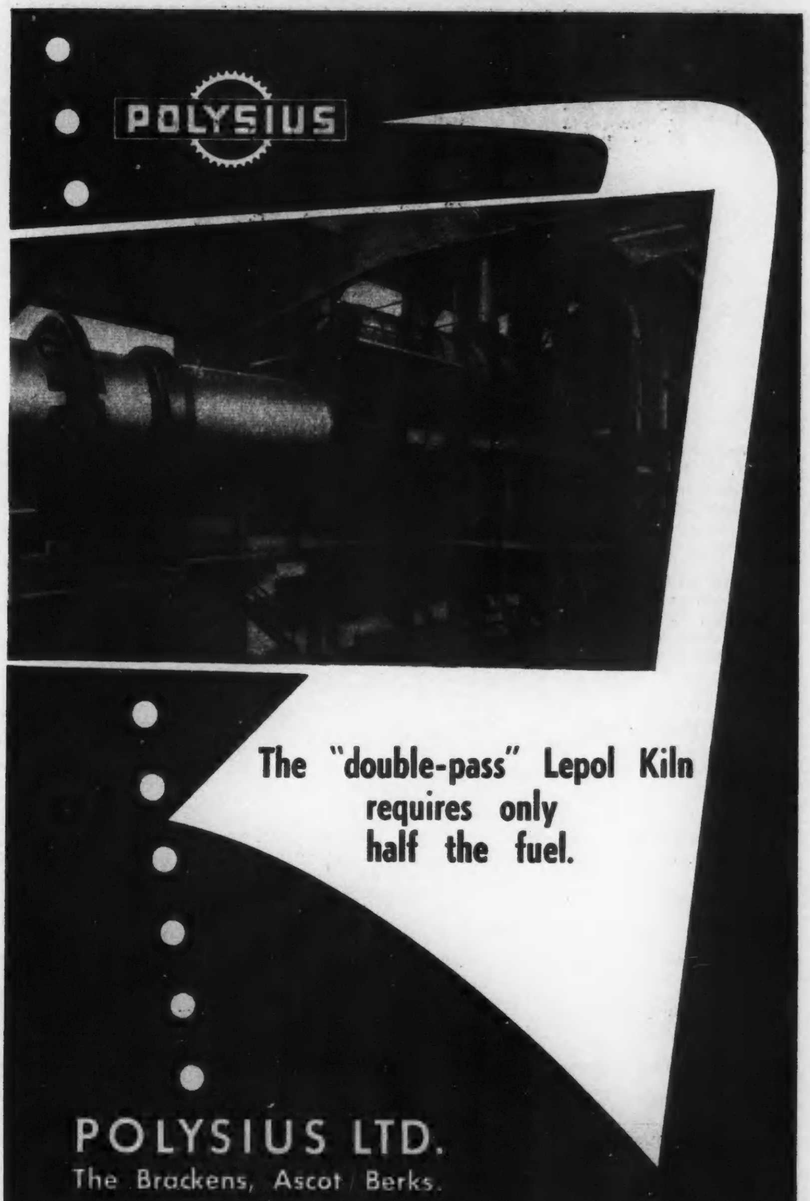
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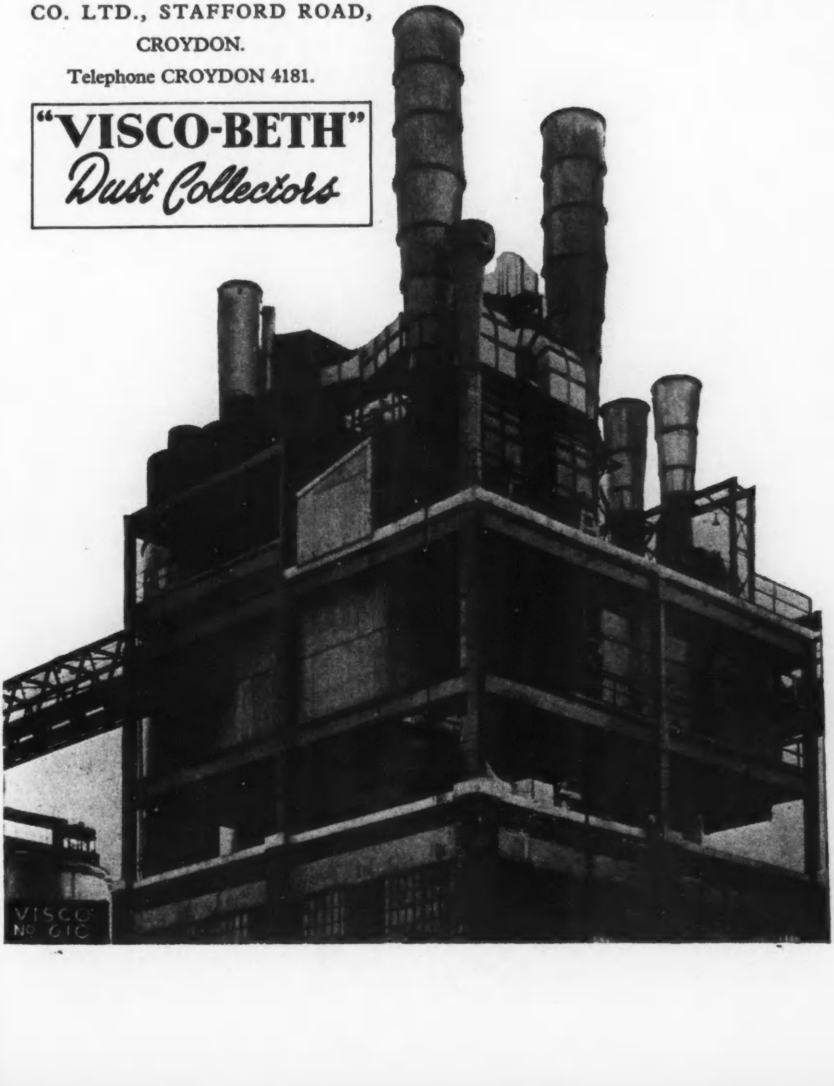
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The Release of Alkalis in Cement Mortar.

A METHOD of evaluating the ability of aggregates and of materials sometimes added to mortars to release alkalis is given by Mr. W. C. Hansen in the Bulletin of the American Society for Testing Materials for February 1959.

The procedure followed was to leach 1-in. by 1-in. by 11¼-in. mortar prisms in de-ionized water and to analyse the extracts periodically for K_2O and Na_2O with a flame photometer. The prisms were made of 1 : 2·75 mortar and cut into four approximately equal lengths as soon as they were moulded. They were cured in the moulds for 24 hours in the moist cabinet at 73·4 deg. F., removed from the moulds, weighed, and immersed in 200 ml. of de-ionized water in a 400-ml. polyethylene beaker. The top of the beaker was sealed by tying a sheet of polyethylene over it, and the beakers were stored in the air of a laboratory in which the temperature was not controlled.

The quantities of alkalis contributed to the prism by the cement were calculated from the weight of the prisms as removed from the mould on the basis that the composition of the specimen was the same as that of the batch of mortar from which it was moulded. Two prisms were tested for each composition studied.

High-alkali and low-alkali cements and standard sands were used. The additions comprised silica gel, quartz, pulverised-fuel ash, calcined shale, sand, and pumicite ground to pass a 100-mesh sieve, and these were used as replacements for 25 per cent. of cement by weight in certain prisms. The alkali content of the cements varied up to 5·78 per cent. It was found that, in general, the amounts of alkalis extracted from the duplicate prisms were very nearly alike for any one period.

Specimens were used as controls to determine the approximate rates at which the alkalis would be released by the cement minerals and pass through the specimen to the water. In about six months about 90 per cent. of the alkalis had been extracted and in one year about 95 per cent. had been extracted. In the case of

specimens made to determine the influence of a powdered admixture upon the rates at which the alkalis would pass through the specimen to the water, the admixture increased the rates of migration.

The quantities of Na_2O extracted from the specimens containing powdered quartz exceeded 100 per cent. of the Na_2O content calculated as available from the cement. This excess may result from several causes. There is a possibility of minor errors in calculating the cement content of the prism and in the determinations of the quantities of Na_2O in the extracts. Also, the quartz flour contained 0·04 per cent. Na_2O and one of the sands contained 0·02 per cent. Na_2O. Many materials are normally considered to be insoluble in water, but probably most of them are either slightly soluble or are decomposed by water. Hence it seems likely that the alkali-bearing minerals in any aggregate will release alkalis to the liquid phase of a hardened cement paste when the alkali content of the liquid phase is very low.

The quantities of alkalis extracted during about one year from mortar prisms containing added materials are as follows (in percentages of the alkali content of the cement): Silica gel: K_2O, 8; Na_2O, 19. Quartz flour: K_2O, 100; Na_2O, 113. Pulverised-fuel ash: K_2O, 125; Na_2O, 217. Calcined Nebraska shale: K_2O, 122; Na_2O, 113. Pumicite: K_2O, 169; Na_2O, 136. Calcined Mowry shale: K_2O, 118; Na_2O, 119. Calcined Monterey shale: K_2O, 92; Na_2O, 95.

It appears that silica gel (produced by precipitation from sodium silicate with acid) reacts readily with alkalis to produce a highly siliceous product which would adhere to the alkalis until they were released by the reaction of the alkali silicate with calcium hydroxide. None of the other admixtures, except Monterey shale, showed a tendency to give a lower rate for the extraction of alkalis than that obtained for the specimens with quartz flour as the admixture. In fact, they appear to release alkalis to the liquid phase of the cement paste. It seems that these are the results to be expected if the materials are pozzolanic unless the pozzolanic material is especially reactive towards alkalis. Pozzolanas react with calcium hydroxide in a water solution to give cementitious products. It seems reasonable to suppose that the SiO_2 and Al_2O_3 in such products would give the same products as are obtained when the cement minerals react with water. Hence, the following or similar reactions might be expected:

$$2SiO_2 + 3Ca(OH)_2 \rightarrow 3CaO \cdot 2SiO_2 \cdot 3H_2O \qquad (1)$$

$$Al_2O_3 + 3Ca(OH)_2 + 3H_2O \rightarrow 3CaO \cdot Al_2O_3 \cdot 6H_2O \qquad (2)$$

If the pozzolanic material contained an alkali, for example Na_2O, in the component that reacted with calcium hydroxide, the following reactions, which are shown in unbalanced form, could then be expected:

$$XSiO_2 \cdot YAl_2O_3 \cdot ZNa_2O + Ca(OH)_2 + H_2O \rightarrow 3CaO \cdot 2SiO_2 \cdot 3H_2O + 3CaO \cdot Al_2O_3 \cdot 6H_2O + NaOH \qquad (3)$$

The hydrated silicates and aluminates formed from pozzolanas should be no more effective in immobilising alkalis than are the hydrated silicates and aluminates formed by the cement minerals.

Certain pozzolanas, such as calcined shale, may consist of two or more components. One or more of these components might be pozzolanic, and therefore

react with calcium hydroxide, whereas one or more might be non-pozzolanic and inert to calcium hydroxide. If the latter components contained alkalis, such alkalis almost certainly would not be released to the liquid phase of cement paste until the alkali content of this phase became very low.

The Monterey shale used contained 1·39 per cent. K_2O and 0·88 per cent. Na_2O, but there is no evidence from the tests that these alkalis are released. Hence it might be concluded that they are present in non-pozzolanic components, but it appears that at least one component of this shale tends to immobilise to some extent the alkalis from the cement. Therefore, it may be that the alkalis in the alkali-bearing component are being released from it and reacting with a very reactive component.

Sands from the Kaw River and Lytle Creek were tested, both as sands and as powdered admixtures, with the high and low-alkali cements. Both of these sands when used as powdered admixtures release both K_2O and Na_2O to the liquid phase of the cement paste. When used as sands they both have some tendency to release Na_2O. It appears that the Kaw River sand might not release alkalis at a sufficient rate to be a source of alkali for alkali-aggregate reaction in concrete, but it appears that the Lytle Creek sand could be the source of alkali for such a reaction.

The low-alkali cement contained 0·15 per cent. K_2O and 0·10 per cent. Na_2O. In about one year the amounts extracted were equivalent to 0·17 per cent. K_2O and 0·22 per cent. Na_2O. The Na_2O equivalent of the original cement was 0·20 per cent. and that of the alkalis extracted was 0·33 per cent. by weight of cement. This is not a very large increase in the alkali, but the conditions in this test may be appreciably different from those in a concrete containing a reactive aggregate. As indicated earlier, an alkali-bearing mineral might release alkalis to the liquid phase of the hardened cement paste only when the concentration of alkalis in this phase was small. In these tests, the concentration of the alkalis is being reduced gradually as the alkalis migrate to the extraction water. The distances through which they have to migrate are extremely large compared with the distances between grains of sand in a mortar. Hence, if a mortar contains a number of grains of a reactive aggregate, these grains may reduce the concentration of the alkalis in the liquid phase of the hardened cement paste to very low levels within a few days. Under such conditions the amounts of alkalis released by a sand in a given period of time may be many times those indicated in these tests.

It appears from the results of this study that the alkali contents of aggregates and admixtures should be considered if the aggregate is known to contain or is suspected of containing components which will react with alkalis. The procedure followed in this investigation appears to offer a method of evaluating the ability of admixtures and aggregates to release alkalis to the liquid phase of hardened cement paste and also the ability of admixtures to combine with alkalis in mortar.

Determination of Calcium Oxide in Hydrated Lime.

BECAUSE it was thought that the sucrose method adopted by the American Society for Testing Materials for determining the amount of calcium oxide or calcium hydroxide in hydrated lime might be inaccurate, Mr. D. R. Moorehead and Mr. W. H. Taylor have made a study of the subject at the Commonwealth Scientific and Industrial Research Organisation, at Highett, Victoria, Australia. The results of this investigation are given in a paper published in the Bulletin of the American Society for Testing Materials for February 1959.

The available calcium oxide in a sample of hydrated lime was determined by total analysis and by analysis of an aqueous extract of the material. Analyses were then made by the sucrose extraction method, using several variations in procedure. These included variations in the period of shaking, the size of the sample, the temperature of the extract, and the proportion of magnesium oxide or hydroxide present. The work was carried out in several stages, and the conclusions derived from results obtained in each step were incorporated in work carried out in the next stage. The results obtained were compared with those determined in the initial analyses.

Freshly-prepared hydrated lime was stored in sealed containers to reduce the effect of atmospheric carbonation. It was dried to constant weight at 120 deg. C. in an atmosphere free from carbon dioxide and passed through a British Standard 200-mesh sieve before being used. Hydrated lime with different content of magnesium oxide was prepared by first mixing calcite with dolomite (both passing a 100-mesh British Standard sieve) in a rotating cylinder for thirty minutes. The material thus contained a predetermined amount of magnesium oxide in natural combination with some calcium oxide. The mixture was then calcined on platinum dishes at 950 deg. C. for three hours, autoclaved in saturated steam at 200 deg. C. for two hours, and dried and stored in sealed containers.

The content of available calcium oxide in the samples was determined in the following ways: (a) Total analysis by A.S.T.M. Methods C.25; (b) Analysis of an aqueous extract; (c) Sucrose extraction method with modifications; and (d) Ethylenediamine tetraacetate (EDTA) procedure on prepared extracts.

The authors state that the investigation has shown that the sucrose extraction method for determining free calcium oxide in hydrated limes gives satisfactory results in a fraction of the time taken to do a total analysis. Accuracy of results is not affected by the amount of magnesium oxide present, but it is affected by the size of the sample. Optimum conditions for accurate results are a sample not exceeding 0·6 g. shaken for fifteen minutes in 100 ml. of 10 per cent. sucrose solution titrated at 21 deg. C. and retitrated at boiling point to ensure complete hydrolysis of the sucrate.

Extension of a Cement Plant in Korea.

The annual capacity of the Oriental Cement works at Samchuk, Korea, is to be increased from 150,000 tons to 300,000 tons at a cost of about £750,000.

Estimating the Cement Content of Hardened Concrete.

THE following method of ascertaining the cement content of hardened concrete and mortar is given by Mr. D. P. Sengupta, of the College of Military Engineering, Kirkee, India, in the "Indian Concrete Journal" for November 1958.

Heat about 1 lb. of concrete at a temperature not exceeding 600 deg. C. for an hour or so to loosen the matrix. Disintegrate the lump cautiously in a mortar with a wooden pestle so that no particle is broken. Separate out all particles retained on a $\frac{3}{16}$-in. sieve, if necessary by careful hand picking. Remove the adhering mortar from all these particles by means of a spatula and add the mortar thus removed to the portion of the concrete passing the $\frac{3}{16}$-in. sieve. Determine the cement contents of these two portions separately as follows.

(*a*).—Note the exact weight of the portion of concrete retained on a $\frac{3}{16}$-in. sieve. Treat it with dilute HCl (1 : 10). Keep the liquid cool by means of running water or ice. If shells or limestones are present remove them quickly with forceps and wash and keep them separately. When the reaction stops, pour off the liquid and wash the residual pieces with water. Reserve the liquid and the washings. Mix the residual pieces with the separated shells or limestones, dry them, and weigh. From the reserved liquid and washings recover the sediment by filtration, wash with water, dry, and weigh. From these weights calculate the loss in weight due to the cement going into solution.

(*b*).—Note the exact weight of the portion passing a $\frac{3}{16}$-in. sieve. Weigh out about 100 gr. of the portion and pulverise to 70-mesh fineness. Digest 1 gr. of the sample with 50 cc. dilute HCl (1 : 9) for 15 minutes at a temperature just short of boiling. Filter the residue on to a Whatman filter-paper No. 41 folded inside a Whatman filter-paper No. 42. The use of two filter papers facilitates quick filtration. Wash the residue on the filter papers several times with hot water. Reserve the filtrate and washing. Now digest the filter papers with the contents with 100 cc. solution of 1 per cent. NaOH for 15 minutes at a temperature just below boiling. Using methyl red as indicator, titrate the solution with HCl. Add four or five drops more of HCl and filter, using two filter papers as before. Wash the residue at least twelve times with hot NH_4Cl solution (20 gr. per litre). Mix the two filtrates and washings. Add to it 5 cc. HCl, evaporate to dryness, and bake at about 105 deg. C. for an hour. Extract the baked mass with dilute HCl by boiling, filter, and wash. Dry the precipitate, ignite in a platinum crucible at 1,000 deg. C. and weigh. Lastly, add 10 cc. HF together with a drop of H_2SO_4 to the ignited mass, evaporate to dryness, ignite at 1,000 deg. C. for a few minutes and weigh. The difference of the two weights gives the amount of SiO_2.

(*c*).—For determination of CaO, take 1 gr. of the pulverised sample and bake it with HCl. Boil the baked mass with dilute HCl, filter, and wash with hot water. Boil the filtrate with a few drops of HNO_3. Add to the solution NH_4Cl first and then NH_4OH. Allow the precipitate to settle, filter, and wash with hot water. Take the filtrate, make it just acidic to methyl red with dilute HCl,

and boil. Add hot ammonium oxalate solution, make just ammoniacal, and allow to stand in a water-bath for a few hours. Filter and wash the precipitate several times with cold 0·1 per cent. ammonium oxalate solution. Dry the precipitate, ignite at 1,000 deg. C. for an hour, and weigh. This gives the amount of CaO.

(*d*).—Determine the loss on ignition of the sample and calculate the percentage of SiO_2 or CaO on the ignited basis to eliminate possible large errors caused by changes in moisture and carbon dioxide content of the specimen.

(*e*).—Analyse the sand and cement in exactly the same manner.

(*f*).—The percentage of cement in the portion of concrete retained on a $\frac{3}{16}$-in. sieve is calculated as follows.

Percentage of cement $= \frac{X-Y}{Z} \times 100$, in which X is the percentage of SiO_2 or CaO in the concrete, Y is the percentage of SiO_2 or CaO in the sand (correction factor), and Z is the percentage of SiO_2 or CaO in the cement.

The total cement content of the concrete is the sum of the weight obtained by method (*a*) and the weight derived from the calculation in (*f*).

The cement content of the portion retained on the $\frac{3}{16}$-in. sieve is very small and is determined by method (*a*) by noting the loss in weight after treatment with dilute hydrochloric acid. The weight of the residue is the amount of coarse aggregate.

The portion passing the $\frac{3}{16}$-in. sieve contains most of the cement and sand. The cement content of this portion is obtained by method (*b*) by estimating the soluble SiO_2 content. In some cases the cement content should be calculated as in method (*c*) from determination of the CaO content. The basis of methods (*b*) and (*c*) is the fact that cement contains about 22 per cent. of soluble SiO_2 and 63 per cent. of CaO, which are assumed to be liberated by the cement only under the conditions of the test. Both methods must be used with discretion. If the sand liberates soluble SiO_2, method (*b*) should not be used. Similarly, if the sand is calcareous, method (*c*) cannot be used. It is essential to make blank tests (*e*) on the cement and sand. The tests on the sand are to determine the soluble SiO_2 and CaO contents, which are used as correction factors for the soluble SiO_2 or CaO contents obtained from the concrete. If the sand liberates both soluble SiO_2 and CaO, the ratio of the SiO_2 content of the sand to the SiO_2 content of the cement and the ratio of the CaO content of the sand to the CaO content of the cement should be calculated. The constituent giving the smaller ratio should be used, since the error will be less.

Production of Cement in Tunisia.

Due to a reduction in exports, the production of cement in Tunisia fell from 449,000 metric tons in the year 1957 to 300,000 metric tons in 1958.

Revised Methods of Testing Cement in accordance with U.S.A. Standards.

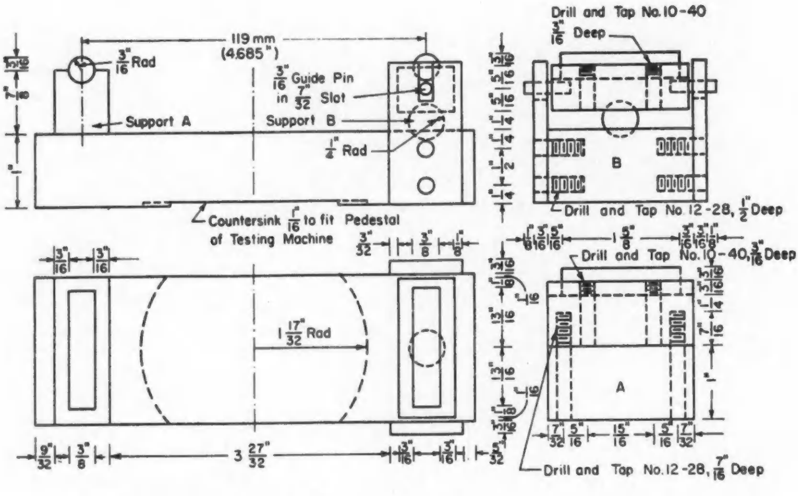
In this journal for May, 1959, particulars are given of the revisions made to the physical and chemical requirements of cement in accordance with the latest standards of the American Society for Testing Materials. In the following are given the revisions to methods of testing and apparatus used in the tests.

Cement Pastes and Mortars.

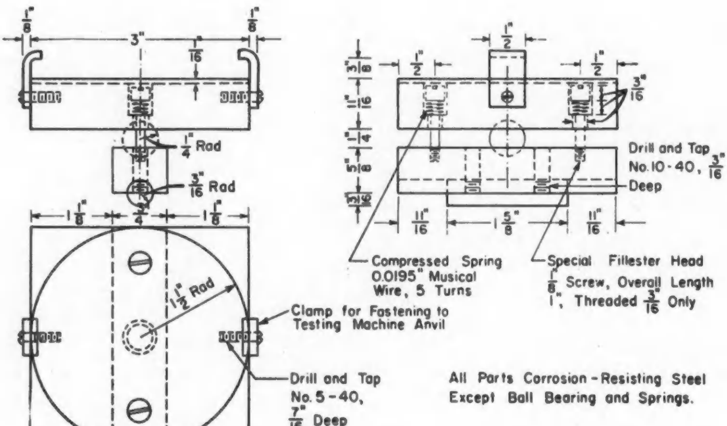
Portland Pozzolanic Cement.—The mortar for the test to determine the activity of the pozzolana is given in Standard C340-1958 (tentative) as 2 parts of pozzolana, 1 part of hydrated lime and 9 parts of sand. The amount of water shall be such that the flow is 110 per cent., the flow being in accordance with the method described in Standard C109. The mortar is mixed in accordance with Standard C305 except that the pozzolana and lime, which are mixed dry, are added to the water, and then mixed at a speed of 140 revolutions per minute for thirty seconds.

"Bleeding" of Cement Pastes and Mortars.—The revised requirements in Standard C243-1958 (tentative) for a test for "bleeding" of cement pastes and mortars are that the mixing shall be in accordance with Standard C305; the mixer shall be operated at low speed throughout; there shall be a waiting period of three minutes between preliminary and final mixing in order to avoid the effect of thixotropic set; and the preliminary and final mixing shall each be for a period of three minutes. Pastes shall be mixed in the following manner. Place all the mixing water in the bowl. Add the cement to the water and mix for three minutes at slow speed. Let the paste stand for three minutes; during the first fifteen seconds of this interval, scrape down quickly into the batch any paste that may have collected on the side of the bowl; then for the remainder of this period, cover with a damp cloth or lid. Mix for three minutes at slow speed.

Compressive Strength of Mortars.—Revisions to the method of test for the compressive strength of hydraulic cement mortars (Standard C349-1957), using portions of prisms broken in the bending test (Standard C348-1957), include reduction in the size of the bearing-plates in contact with the specimen to 1·588in. square. Also, if the upper bearing-plate does not have free movement within the aligning plates, these shall be separated from the bottom plate by the insertion of 0·002-in. shims on each side of the bottom bearing-plate. The testing machine shall be of the hydraulic type. During the interval between bending tests of the prisms and testing the broken portions as cubes, the specimens for the 24-hours' test shall be covered with plastic cloth and all other specimens shall be completely immersed in water at a temperature of 23 deg. C. (73·4 deg. F.) until the time of testing. The testing of the broken portions shall follow breaking in bending within ten minutes for 24-hours' specimens and within thirty minutes for all other



(a) Base-plate and support edges for Bending Tests of 40-m.m. by 40-m.m. by 160-m.m. Mortar Prisms.



(b) Centre-point loading device for testing 40-m.m. by 40-m.m. by 160-m.m. Mortar Prisms.

Fig. 1.—Compression Testing Machine.

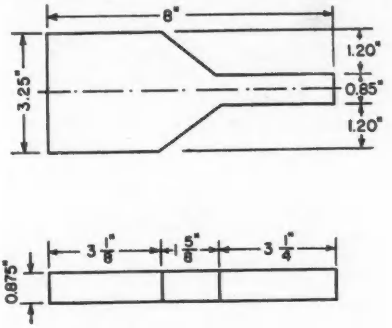


Fig. 2.—Tamper.

specimens. The compressive strength in pounds per square inch is calculated to the nearest 10lb. per square inch from $0{\cdot}40P$ where P is the total maximum load in pounds.

FALSE SETTING.—The apparatus used in the test for determining false setting of Portland cement [Standard C359-1956 (tentative)] is the Vicat apparatus described in Standard C191 except that the needle of 1 mm. diameter is replaced by a weight such that the total weight of the 1-cm. plunger, indicator, and additional weight is 400 g.

BENDING STRENGTH OF MORTARS.—The test to determine the bending strength of hydraulic cement mortars (Standard C348-1957) is now to be made on specimens 1·575 in. square by 6·3 in. long. The tolerances have been slightly changed. The tamper (*Fig.* 2) shall be made of non-absorptive and non-abrasive material, such as a rubber compound having a Shore A durometer hardness of 80, or seasoned oak rendered non-absorptive by immersion for fifteen minutes in paraffin

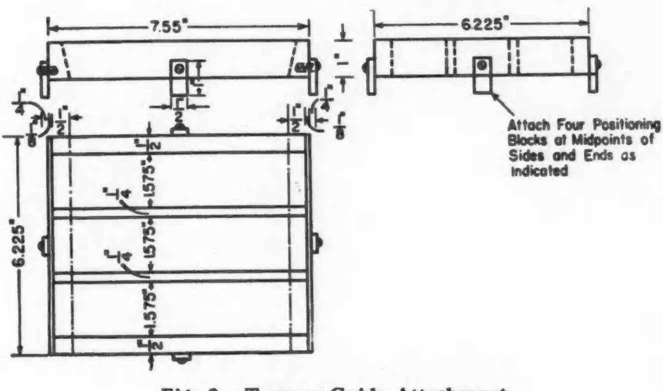


Fig. 3.—Tamper Guide Attachment.

Table I.—Standard Sieves.

Size or Sieve Designation	Sieve Opening		Permissible Variations in Average Opening, per cent	Permissible Variations in Maximum Opening, per cent	Nominal Wire Diameter	
	mm	in. (approx equivalents)			mm	in. (approx equivalents)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
COARSE SERIES						
(4.24-in.)	107.6	4.24	±2	+3	6.40	0.2520
4-in.	101.6	4.00	±2	+3	6.30	0.2480
3½-in.	88.9	3.50	±2	+3	6.08	0.2394
3-in.	76.2	3.00	±2	+3	5.80	0.2283
2½-in.	63.5	2.50	±2	+3	5.50	0.2165
(2.12-in.)	53.8	2.12	±2	+3	5.15	0.2028
2-in.	50.8	2.00	±2	+3	5.05	0.1988
1¾-in.	44.4	1.75	±2	+3	4.85	0.1909
1½-in.	38.1	1.50	±2	+3	4.59	0.1807
1¼-in.	31.7	1.25	±2	+3	4.23	0.1665
(1.06-in.)	26.9	1.06	±3	+5	3.90	0.1535
1-in.	25.4	1.00	±3	+5	3.80	0.1496
⅞-in.	22.2	0.875	±3	+5	3.50	0.1378
¾-in.	19.1	0.750	±3	+5	3.30	0.1299
⅝-in.	15.9	0.625	±3	+5	3.00	0.1181
(0.530-in.)	13.4	0.530	±3	+5	2.75	0.1083
½-in.	12.7	0.500	±3	+5	2.67	0.1051
7/16-in.	11.1	0.438	±3	+5	2.45	0.0965
⅜-in.	9.52	0.375	±3	+5	2.27	0.0894
5/16-in.	7.93	0.312	±3	+5	2.07	0.0815
(0.265-in.)	6.73	0.265	±3	+5	1.87	0.0736
¼-in. (No. 3)	6.35	0.250	±3	+5	1.82	0.0717
FINE SERIES						
5660 micron (No. 3½)	5.66	0.223	±3	+10	1.68	0.0661
4760 micron (No. 4)	4.76	0.187	±3	+10	1.54	0.0606
4000 micron (No. 5)	4.00	0.157	±3	+10	1.37	0.0539
3360 micron (No. 6)	3.36	0.132	±3	+10	1.23	0.0484
2830 micron (No. 7)	2.83	0.111	±3	+10	1.10	0.0430
2380 micron (No. 8)	2.38	0.0937	±3	+10	1.00	0.0394
2000 micron (No. 10)	2.00	0.0787	±3	+10	0.900	0.0354
1680 micron (No. 12)	1.68	0.0661	±3	+10	0.810	0.0319
1410 micron (No. 14)	1.41	0.0555	±3	+10	0.725	0.0285
1190 micron (No. 16)	1.19	0.0469	±3	+10	0.650	0.0256
1000 micron (No. 18)	1.00	0.0394	±5	+15[a]	0.580	0.0228
840 micron (No. 20)	0.84	0.0331	±5	+15[a]	0.510	0.0201
710 micron (No. 25)	0.71	0.0280	±5	+15[a]	0.450	0.0177
590 micron (No. 30)	0.59	0.0232	±5	+15[a]	0.390	0.0154
500 micron (No. 35)	0.50	0.0197	±5	+15[a]	0.340	0.0134
420 micron (No. 40)	0.42	0.0165	±5	+25[a]	0.290	0.0114
350 micron (No. 45)	0.35	0.0138	±5	+25[a]	0.247	0.0097
297 micron (No. 50)	0.297	0.0117	±5	+25[a]	0.215	0.0085
250 micron (No. 60)	0.250	0.0098	±5	+25[a]	0.180	0.0071
210 micron (No. 70)	0.210	0.0083	±5	+25[a]	0.152	0.0060

(*Continued on page 57*).

Table I.—Standard Sieves (*Continued.*)

177 micron (No. 80)......	0.177	0.0070	±6	+40[a]	0.131	0.0052
149 micron (No. 100)......	0.149	0.0059	±6	+40[a]	0.110	0.0043
125 micron (No. 120)......	0.125	0.0049	±6	+40[a]	0.091	0.0036
105 micron (No. 140)......	0.105	0.0041	±6	+40[a]	0.076	0.0030
88 micron (No. 170)......	0.088	0.0035	±6	+40[a]	0.064	0.0025
74 micron (No. 200)......	0.074	0.0029	±7	+60[a]	0.053	0.0021
63 micron (No. 230)......	0.063	0.0025	±7	+60[a]	0.044	0.0017
53 micron (No. 270)......	0.053	0.0021	±7	+60[a]	0.037	0.0015
44 micron (No. 325)......	0.044	0.0017	±7	+60[a]	0.030	0.0012
37 micron (No. 400)......	0.037	0.0015	±7	+60[a]	0.025	0.0010

at about 200 deg. C. (392 deg. F.). The face of the tamper shall be $\frac{7}{8}$ in. by $3\frac{1}{4}$ in. (which is smaller than the previous size which was in accordance with German standards). The tamper guide (*Fig.* 3) shall be made of brass of Rockwell hardness not less than B55, or other metal not attacked by cement mortar. It shall lie flat on the mould and shall not protrude over any interior edge of the mould more than 0·015 in. The height of the guide shall be 1 in. The trowel shall have a steel blade $4\frac{1}{2}$ in. by 10 in. and a wooden handle.

The compression-test machine used with the bending test device is hydraulically operated; details are given in *Fig.* 1.

The remaining apparatus and method of test are as in previous issues of this standard with the following revisions. The mortar shall conform to the requirements of Standard C109 except that the flow shall be 110 ± 5 after twenty-five falls of the flow-table, and the quantity of dry material in one batch for making three prisms shall be 500 g. of cement and 1,375 g. of sand. Immediately after the flow test, the mortar is returned to the mixing bowl and remixed for fifteen seconds at medium speed. Immediately following remixing, a layer of mortar about $\frac{3}{4}$ in. thick is distributed evenly in each of the three moulds with the tamper guide in place. The mortar in each mould is compacted by twelve strokes of the tamper, applied in three rounds of four strokes each, completing the twelve strokes in about fifteen seconds. For each stroke the face of the tamper is held in a horizontal position about 1 in. above the mortar and then thrust downwardly with sufficient force to squeeze out a small amount of mortar from under the tamping surface. The moulds are then filled with mortar distributed uniformly and tamped in the same manner as the bottom layer. The tamper guide is removed and the tops of the specimens are smoothed. The mortar is cut off flush with the top of the moulds. After cutting, tears or cracks in the top surfaces are repaired and the surfaces of the specimens made plane by two or three light longitudinal strokes of the trowel held with the leading edge slightly raised.

For the loading test the longitudinal centre-line of the specimen shall be directly above the mid-point of the supports. The specimen is loaded at the centre of the span of length 4·685 in. Contact between the specimen and the loading edge must be continuous when the load is applied. The bending strength is $1{\cdot}8P$ lb. per square inch (P is the maximum load in pounds applied as indicated by the testing machine).

TENSILE STRENGTH.—The trowel used in making samples for the test for the tensile strength of mortars should have, in accordance with Standard C190-1958, a blade 4 in. to 6 in. long.

Sieves

The sizes of wires for woven-wire sieves are revised in Standard E11-1958 (Sieves for Testing Purposes) so that only the nominal diameter is given, as in columns (6) and (7) in *Table I* (instead of the maximum and minimum diameter).

Calcium Sulphate

The test for calcium sulphate described in Standard C265-1958 (tentative) is intended primarily for makers of Portland cement and research workers. Metal moulds and moist closets are replaced by polyethylene bags of 1 quart capacity or 14-in. square of polyethylene sheet. The thickness of the polyethylene should be not less than 0·004 in. Immediately after mixing the mortar for the test. the batch is separated and about 450 g. of mortar are placed in each of two poly-

Fig. 4—Sampler for Loose Cement.

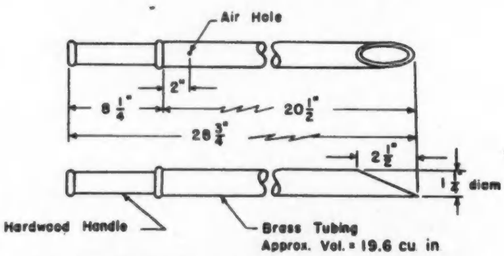


Fig. 5.—Tube Sampler for Cement In Bags.

ethylene containers. The temperature of each portion should be between 72·4 and 74·4 deg. F. If bags are used, twist the neck of each and seal with a rubber band; double the neck over and seal with a second band. If sheets are used, gather the corners and edges to make a bag and seal in a similar manner. Immerse both containers immediately in a water bath the temperature of which is thermostatically maintained at 73·4 deg. F.

Sampling

A revised method is described in A.S.T.M. Standard C183-1958 (tentative) for obtaining samples of cement stored loose. When the depth of the cement does not exceed 7ft. samples may be obtained by a slotted tube (*Fig.* 4) between 5 ft. and 6 ft. long and about 1⅜ in. outside diameter. The tube comprises two polished brass telescopic tubes with registering slots which are opened or closed by rotation of the inner tube. The outer tube has a sharp point to facilitate pene-

tration. For depths of cement greater than 7 ft., a pipe is used in conjunction with an air jet and capable of removing samples from different depths in the cement being tested. Samples obtained with the tube or pipe shall be taken from well-distributed points and at various depths so that the samples represent truly the cement.

For sampling cement in bags, a tube (*Fig.* 5) is inserted diagonally into the valve of the bag; the thumb is placed over the air-hole, and the tube withdrawn. Samples taken from one bag in each 25 barrels (a barrel contains 360 lb.) or fraction thereof are combined to form the test sample.

Chemical Tests for Portland Cement in Portugal.

THE Laboratório Nacional de Engenharia Civil of the Portuguese Ministério das Obras Públicas has issued a number of standard methods of determining the chemical composition of Portland cement. These include: " Determinação do Teor em Oxido Férrico ", " Determinação do Teor em Oxido de Magnésio ", " Determinação do Teor em Componentes do Grupo do Hidróxido de Amónio ", " Determinação do Teor em Oxido decálcio ", " Determinação do Teor em Anidrido Silícico ", and " Determinação do Teor em Andrido Fosfórico ". Summaries of the tests are as follows:

FERRIC OXIDE.—The procedure to determine the ferric-oxide content is the dissolution of the sample, reduction by means of stannous chloride, and titration with a standard potassium-dichromate solution.

MAGNESIUM OXIDE.—Two methods of analysis to determine the magnesium-oxide content are described. The quick method is to precipitate the magnesium by means of di-ammonium phosphate in the calcium filtrate acidified with hydrochloric acid. The residue is filtered, calcined and weighed. The referee method is to precipitate the magnesium as in the quick method, followed by redissolution of the precipitate and a repeat precipitation. The residue is then filtered, calcined and weighed.

AMMONIUM HYDROXIDE.—Two methods of analysis to determine the ammonium-hydroxide group in the cement are described. The quick method comprises the precipitation of the ammonium-hydroxide group in the filtrate of silica, followed by redissolution, precipitation, and calcination of the residue. The referee method comprises the precipitation of the ammonium-hydroxide group in the filtrate of silica, separation by filtration of the ammonium-hydroxide group and the silica which may be present in the filtrate, followed by calcining the residue and rendering it soluble, separation of the silica, and its removal by hydrofluoric acid.

CALCIUM OXIDE.—Two methods of analysis to determine the calcium-oxide content are described. The quick method comprises precipitation of the calcium by means of ammonium oxalate in the filtrate of the ammonium-hydroxide group, separation by filtration, dissolution of the precipitate with sulphuric acid, and titration of the oxalic acid by means of a standard solution of potassium

permanganate. The referee method comprises precipitation of the calcium as in the optional method, separation of the calcium oxalate by filtration, redissolution, and calcination of the precipitate.

SILICON DIOXIDE.—The quick method of determining the silicon-dioxide content comprises the addition of hydrochloric acid to the sample, followed by filtration and calcination of the residue, which is then dissolved in hydrofluoric acid. The product of this operation is then filtered and the residue is calcined. The referee method is to add hydrochloric acid to the sample, filter, and evaporate to dryness the residue and the filtrate. The residue is calcined and hydrofluoric acid is added to the silica; the resulting liquid is treated with pyrosulphate of sodium or potassium.

PHOSPHORUS PENTOXIDE.—To determine the phosphorus-pentoxide content, nitric acid is added to the sample, the silica is separated, and the phosphorus is precipitated by means of ammonium molybdate. This is followed by filtration, redissolution of the precipitate with ammonia liquor, and precipitation of the phosphorus by means of magnesia mixture. The precipitate is filtered, calcined, and weighed.

New Cement Works in Nigeria.

In May last the Premier of the Western Region of Nigeria, Chief the Hon. Obafemi Awolowo, unveiled a plaque commemorating the construction of a cement works for the West African Portland Cement Co., Ltd. The Premier was welcomed by Mr. J. A. E. Reiss, B.E.M. (Chairman of the Associated Portland Cement Manufacturers, Ltd.), Mr. A. O. Rewane (Chairman of the Western Nigeria Development Corporation, a body sponsored by the Western Nigerian Government), and Mr. F. S. Pardoe (Regional Director of the United Africa Co. of Nigeria, Ltd.).

The works is at Ewekoro, and is the largest manufacturing project in Nigeria. The cost is estimated at £4,000,000, which is being subscribed by the Associated Portland Cement Manufacturers, Ltd., the Western Nigeria Development Corporation, and the United Africa Co., Ltd., in the proportions of 51 per cent. 39 per cent. and 10 per cent. respectively. The factory is expected to be in production before the end of next year. It is designed for a capacity of 200,000 tons a year, and provision is made for future expansion. About 24 Europeans and 280 Nigerians will be employed; Nigerians are being trained in the United Kingdom by the Associated Portland Cement Manufacturers, Ltd

Expansion of Cement Works in Indonesia.

The production of the Indarung cement factory is to be increased to 200,000 tons a year by the installation by 1960 of an additional blastfurnace which is to be imported from Japan. The Gresik cement works is to be enlarged at a cost of about £2,460,000.

The Cement Industry in Great Britain.

THE following is taken from the address of the chairman, Mr. J. A. E. Reiss, B.E.M., to the stockholders of the Associated Portland Cement Manufacturers, Ltd., which was held in London on June 30.

From the middle of last year there was a steady improvement in the demand for cement, with the result that the total deliveries were only slightly less in 1958 than in 1957.

The cement industry gave another undertaking in the middle of 1958 to maintain the price of cement for a further year unless there was an increase in the cost of coal or something unexpected and exceptional happened during the period. The price of cement had remained stable for two years, and it had been agreed to maintain the present price until June 1960. Difficulties in export trade continued to be experienced and there was a severe reduction in profits. In view of the unfavourable factors operating, however, the quantity of cement exported was not unsatisfactory.

So far all the indications were that there would be a considerable improvement in demand at home, and for the first six months of 1959 the Company's despatches increased by 7 per cent. compared with the same period last year. He thought that the industry could now look forward to a return of the normal increase in the consumption of cement each year that was temporarily halted in 1957.

It had been decided to double the output of the new works at Cauldon, which is now operating economically, and it was hoped that a new kiln capable of producing more than 200,000 tons a year would be in operation by the end of next year. The cement works that was acquired last year at Plymouth had given satisfactory results, and it was planned to increase its capacity by erecting a rotary kiln.

In a few months' time oil burning would be installed at a group of the Company's works on the Thames. This was the culmination of long and protracted negotiations spread over two years, and would put the Company in a better competitive position at two of its main exporting works, as the use of oil fuel would make important savings in the cost of cement. There would be an additional benefit in the consistent quality of the oil compared with the big variations in the ash content of the coal that had been supplied in the past.

The Company could not hope to increase exports and must expect that profits would further contract. A great deal of attention was being given to the production of special types of cement, and these special products sold extremely well last year both at home and abroad. It was now planned to make masonry cement at eight works.

OVERSEA COMPANIES.—The Commonwealth Portland Cement Co., Ltd., in New South Wales, again achieved record sales and profits. There were signs of increasing competition, but it was anticipated that the Company would have another good year. In addition to making cement, the Company owned a controlling interest in the largest paper-bag making concern in Australia, which made bags for other industries at Sydney, Melbourne, and Perth.

Ocean Cement & Supplies, Ltd., the holding company of the British Columbia Cement Co., Ltd., had a difficult year. The effects of the recession were accentuated by strikes in the Province, and trade in general was considerably reduced. The industrial disputes had been settled but some time would elapse before business returned to the peak of 1957.

The works near Nairobi, which started production in March, 1958, was operating satisfactorily. Productive capacity in Kenya was at present in excess of demand, but the works was well sited to secure its share of the market.

In Malaya a new kiln, which more than doubled the capacity of the factory, was lit in January last, and was operating well. Demand remained satisfactory, but keen competition of imports from other countries was being experienced in parts of the Federation.

Both the companies in which they were interested in Mexico had a good year, and prospects for 1959 were regarded as satisfactory. Construction proceeded on the new works with a capacity of 300,000 tons a year which their associates were building some forty miles from Mexico City.

A new kiln with a capacity of 200,000 tons a year, at the works of the Golden Bay Cement Co., Ltd., in New Zealand, was expected to be in operation shortly. Productive capacity in the Dominion would exceed potential demand for some time, but the Company was well served by modern plant and facilities for economical distribution by its ship for carrying loose cement.

The two works in South Africa owned by White's South African Portland Cement Co., Ltd., again achieved record results. Building in the Union showed some signs of contracting after the large construction programmes of recent years, but this was regarded as temporary and long-term prospects remained good.

In its first full year of production the Salisbury Portland Cement Co., Ltd., made sufficient profit to liquidate its pre-production expenses and carry forward a small balance. While construction in the Salisbury area was appreciably lower than in the years following the inauguration of the Federation, the Company was admirably situated to take full advantage of the increase in business which must eventually materialise.

Construction of the works, with a capacity of 200,000 tons a year, in Western Nigeria proceeded satisfactorily. It was expected that it would be in production by late 1960, when Nigeria would receive its independence.

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